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Art. XII.—*Notes on the Middle Palaeozoic Stromatoporoid Faunas of Victoria.*

By ELIZABETH A. RIPPER, M.Sc., Ph.D.

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Contents.

Introduction.

The writer has, in a recent series of papers, described the stromatoporoid faunas of the Yeringian limestones of Lilydale (1933, 1937), Loyola (1937), and of the Middle Devonian limestones of the Buchan district (1937), and it now seems appropriate to attempt analyses of these faunas, arriving thereby at a comparison with one another and with the faunas of other regions. In summing up the characteristics of the assemblages after describing the species contained in them, the main stress was laid on the occurrence and relative abundance of those species which had previously been described from other regions. After the examination of some of the typical Silurian and Devonian assemblages, however, it seems possible to trace progressive changes in certain genera which may be employed in assessing the evolutional stages reached by the various Victorian assemblages. It is thus possible, in an analysis based on evolutional considerations, to include the new species, which are, as far as at present known, confined to Victoria, and so complete the summaries of faunal characteristics given in earlier papers.

The Genus ACTINOSTROMA.

The species of the genus *Actinostroma* fall into three well-defined groups, which are distinguished on account of the varying relations between the laminae and pillars.

1. Group of *A. intertextum* Nich.

The radial pillars are fairly long, and give off at intervals whorls of lateral processes which are united to form the irregular, discontinuous horizontal laminae. Tangential sections show a fairly complete "hexactinellid" mesh with angular interspaces, and the radial pillars are rarely isolated even in the interlaminar spaces.

Species[1]:

A. intertextum Nicholson	T
A. intertextum var. *suevicum* Nich.	T
A. astroites (von Rosen)	T
A. tenuissimum Parks.	
A. franklinense Parks.	
A. schmidtii (von Rosen)	S
A. podolicum Yavorsky.	
A. intermedium Yavorsky.	
A. pexisum Yavorsky.	
A. perforatum Parks.	
?*A. mirum* Parks.	
A. whitcavesii var. *niagarense* Parks.	

These species are all of Silurian age. A single Devonian species, *A. whitcavesii* Nich. and the Yeringian species *A. altum* Ripper also show these characters.

2. Group of *A. clathratum* Nich.

The radial pillars are rather short, undulating, and give off whorls of lateral processes, as in the species of the first group. These coalesce and form fairly well defined horizontal laminae. Tangential sections show the mesh on the levels of the laminae to be imperfectly "hexactinellid", but the radial pillars are frequently isolated in the interlaminar spaces.

Species:

A. clathratum Nich.	T
A. bifarium Nich.	T
A. hebbornense Nich.	T
A. verrucosum (Goldfuss)	S
?*A. fenestratum* Nich.	T
A. vastum Počta	
A. frustulum Počta	
A. expansum (Hall and Whitfield)	S

These species are all of Devonian age. *A. compactum* Ripper of the Victorian Yeringian also shows these characters.

[1] Throughout the lists of species in these groups, the letter T placed against a form indicates that the type material has been examined by the writer; S indicates that specimens of that species, but not the type material, have been examined. The other species have been grouped on the evidence of descriptions and figures only, and these groupings must be regarded as merely provisional.

3. Group of *A. stellulatum* Nich.

The radial pillars are long and regular; the horizontal laminae are straight, continuous and solid, usually with small perforations. The radial pillars in the interlaminar spaces are isolated. The skeletal fibre in some species may be finely porous, but this is observable only under exceptional conditions of preservation.

Species:

A. vulcanum Parks.	
A. tenuifilatum Parks.	
A. tenuifilatum var. *inflectum* Parks.	
A. tenuifilatum var. *cylindricum* Parks.	
A. matutinum Nich.	T
A. praecursum Parks.	
A. stellulatum Nich.	T
A. stellulatum var. *italica* Gortani.	
A. stellulatum var. *distans* Ripper.	T
?*A. perspicuum* Počta.	
?*A. contextum* (Barrande).	
A. tyrrelli Nich.	T
A. contortum Ripper.	T

Of these species *A. vulcanum* Parks, *A. tenuifilatum* Parks and its varieties, *A. matutinum* Nich. and *A. praecursum* Parks are Silurian; the rest are Devonian.

The specimens of *A. clathratum* identified by Nicholson from the Rough Range, opposite Mt. Krauss, Western Australia (Brit. Mus. Nat. Hist., Reg. Nos. P4463, P4965, P4967), in which the pillars are long and isolated in the interlaminar spaces, but connected by processes forming a perfect "hexactinellid" mesh on the levels of the laminae, are probably transients between groups 2 and 3.

The distribution of Silurian and Devonian species in these three groups suggests that those forms in which the construction of the laminae from the whorls of radiating fibres of the radial pillars is obvious are the more primitive. They are most abundant in the Silurian. The members of group 2 are possibly survivors of this group which have passed up in a modified form into the Devonian. The laminae become strengthened and the whorls of processes are restricted to more clearly defined levels, so that the radial pillars tend to become isolated in the interlaminar spaces. In group 3, consisting mainly of Devonian species, this tendency is still more marked, and the laminae are continuous and sometimes solid, the processes being completely fused to form perforated plates. The radial pillars are isolated in the interlaminar spaces. *A. stellulatum* itself has finely porous skeletal fibre, and forms having thickened, isolated pillars and fine, continuous laminae, e.g., *A. contextum* (Barrande), seem to have affinities with *Syringostroma*. The presence of some forms allied to *A. stellulatum* in the Silurian shows that the tendency towards thickening of the horizontal laminae, or of fusion of the fibres composing them, asserted itself at an early stage in the history of the genus *Actinostroma*.

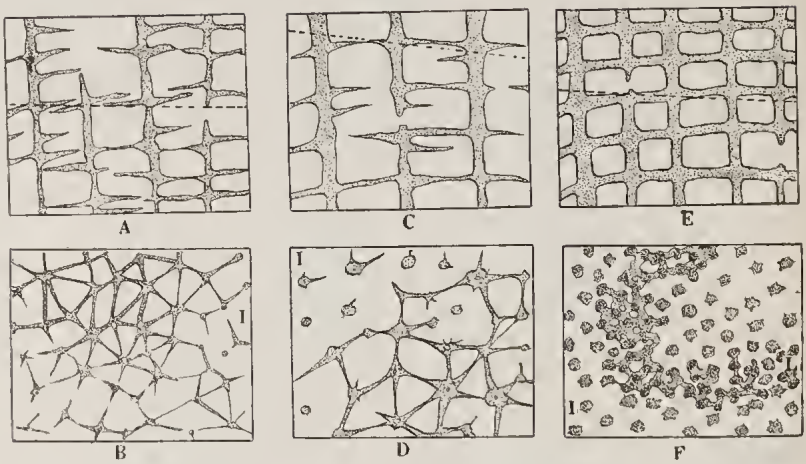

Fig. 1.—Diagrammatic sections illustrating the progressive thickening of the laminae in *Actinostroma*. The longer sides of the rectangles represent 1 mm. approximately. The dotted lines in the vertical sections indicate the approximate positions of the tangential sections. 1A.—*Actinostroma intertextum* Nich. Group of *A. intertextum*. Wenlock. Vertical section, showing long pillars with lateral processes given off in whorls at irregular intervals, forming ill-defined laminae. 1B.—Same species. Tangential section showing the presence of an imperfect "hexactinellid" mesh produced by the lateral processes given off from the pillars at all levels. The processes are, however, concentrated on the planes of the laminae (*l*), and a few isolated pillars are present in the interlaminar spaces (*i*). 1C.—*A. clathratum* Nich. Givetian. Group of *A. clathratum*. Vertical section showing pillars with lateral processes given off in whorls at more or less regular intervals, forming well-defined laminae. 1D.—Same species. Tangential section showing the increased concentration of the lateral processes on the planes of the laminae (*l*), and the presence of isolated pillars in the interlaminar spaces (*i*). 1E.—*A. stellulatum* Nich. Givetian. Group of *A. stellulatum*. Vertical section showing long, straight pillars and horizontal laminae formed by the fusion of lateral processes given off at extremely regular intervals, and almost completely restricted to those levels. 1F.—Same species. Tangential section showing the almost complete restriction of the lateral processes to the planes of the laminae (*l*), which become thick and perforated. The pillars in the interlaminar spaces (*i*) are usually isolated.

The Genus CLATHRODICTYON.

As recognized by Parks (1908) and Počta (1910) the species of *Clathrodictyon* may be grouped according to the relations between the radial pillars and the concentric laminae. Parks (1908) suggested the following groupings for the Niagara species of *Clathrodictyon,* but does not indicate the possible relations between them:

Group of *C. vesiculosum,* containing
- *C. vesiculosum* Nich. and Murie.
- *C. vesiculosum* var. *minutum* Parks.
- *C. vesiculosum* var. *astrodistans* Parks.
- *C. variolare* (von Rosen).

Group of *C. cystosum,* containing
- *C. cystosum* Parks.
- *C. cystosum* var. *lineatum* Parks.
- *C. cystosum* "folded variety" of Parks, passing into
- *C. fastigiatum* Nich.

Group of *C. striatellum,* containing
- *C. striatellum* (d'Orb.)
- *C. ostiolatum* Nich.
- *C. drummondense* Parks.
- *C. rectum* Parks.

Počta (1910) suggests a classification similarly based on the relation between the pillars and laminae. The first group, in which the straight parallel laminae are sharply separated from the pillars, contains:
- *C. regulare* (von Rosen).
- *C. striatellum* (d'Orbigny).
- *C. ostiolatum* Nich.
- *C. jewetti* Girty.
- *C. drummondense* Parks (pars).

The second group contains those species in which the skeletal mesh is vesicular:
- *C. vesiculosum* Nich. and Murie.
- *C. variolare* (von Rosen).
- *C. crassum* Nich.
- *C. fastigiatum* Nich.
- *C. confertum* Nich.
- *C. cystosum* Parks.
- *C. drummondense* Parks (pars).

Počta considers the structure of these species to be almost sufficiently distinct for their separation under another generic name, but adds that *C. striatellum* connects the two groups.

In a later work Parks (1936), as a result of further work on the North American faunas, traces certain evolutional changes in *Clathrodictyon* (p. 12). He suggests that the genus appears to have developed along two distinct lines in the Silurian and Devonian. In the first series of progressive changes the original form, *C. vesiculosum,* with pillars formed by inflections of the laminate, passes into species belonging to the new genus *Stictostroma,* which contains transients between *Clathrodictyon*

and *Stromatoporella,* and by the acquisition of a perforate structure in the skeletal tissue into *Stromatoporella* itself. The second line of development indicated by Parks is that dealt with in a later section of the present paper: the strengthening of the laminae and the separation of the pillars as distinct skeletal elements in the species *C. striatellum, C. regulare, C. clarum* Počta and others. It is noteworthy, however, that Parks considers *C. striatellum* and two or three American species to be divergent types, in which the heads of the pillars break up into strands. This line of development may, according to Parks, give rise to species in the genera *Trupetostroma* and *Parallelopora.* Without venturing an opinion on the American species, however, it may be suggested that *C. striatellum* finds its place equally well in the series *C. vesiculosum-C. clarum,* in which the later members are produced by straightening of the laminae and definitions of the radial pillars.

The following classification of the species of *Clathrodictyon* is based on work on the Victorian faunas and is an extension of these two. Some attempt is also made to trace the relations between the various groups.

1. Group of *C. cystosum* Parks.

The skeletal mesh is completely vesicular, with no definite pillars or laminae. The group contains the following species:

C. cystosum Parks	Niagaran.
C. cystosum var. *lineatum* Parks ..	Niagaran.
C. cystosum, "folded variety" of Parks	Niagaran.
C. fastigiatum Nicholson	Wenlock. (T)
C. stylotum Parks	Chaleur Group (Silurian).
C. stylotum var. *crassum* Parks ..	Silurian.
C. cellulosum Nich. and Murie ..	Helderbergian. (T)

and possibly—

C. irregulare Boehnke	Silurian erratics of North Germany.

2. Group of *C. vesiculosum* Nich. & Murie.

This group contains those species of *Clathrodictyon* in which the laminae are thin and crumpled, and the pillars are oblique and indefinite.

C. vesiculosum Nich. and Murie ..	Wenlock. (T)
C. vesiculosum var. *minutum* Parks ..	Niagaran.
C. vesiculosum var. *astrodistans* Parks ..	Niagaran.
C. vesiculosum var. *laminatum* Riabinin ..	Silurian.
C. variolare (v. Rosen)	Ordovician, Silurian. (T)
C. variolare var. *vaigatschense* Yavorsky	Silurian.
C. crassum Nich.	Wenlock. (T)
C. linnarssoni Nich.	Wenlock. (T)
C. rosarium S. Smith	Valentian.
C. conophoroides Eth. fil.	Upper Silurian.
C. confertum Nich.	Middle Devonian. (T)

and possibly—

C. yavorskyi Riabinin	Lower part of Upper Devonian.

3. Group of *C. striatellum* (d'Orbigny).

This group contains those species of *Clathrodictyon* in which the skeletal mesh is regular, with straight pillars formed more or less obviously by the downward inflection of the slightly crumpled laminae:

C. striatellum (d'Orb.)	Ordovician, Wenlock. (S)
C. regulare (v. Rosen)	Wenlock. (S)
C. ostiolatum Nich.	Niagaran. (T)
C. crickmayi Parks	Chaleur Group (Silurian).
C. drummondense Parks	Niagaran.
C. socium Počta	Ee2 of Bohemia (Wenlock).
C. salairicum Yavorsky	Silurian.
C. convictum Yavorsky	Oesel Group (Upper Silurian).
C. alternans Boehnke	Silurian erratics of North Germany.
C. spatiosum Boehnke	Silurian (N. Germany).
C. rectum Parks	Niagaran.
C. calamosum Ripper	Yeringian. (T)
C. regulare var. *cylindrifera* Ripper ..	Yeringian. (T)
C. regulare var. *carnica* Vinassa ..	Middle Devonian.
C. jewetti Girty	Helderbergian.
C. neglectum Počta	Ff2 (Lower Devonian).
C. subtile Počta	Ff2.
C. clarum Počta	Ff2.
C. katavensis Yavorsky	Upper part of Middle Devonian.
C. praeternum Yavorsky	Middle Devonian.
C. pseudostriatellum Yavorsky	Middle Devonian.
C. variabilis Riabinin	Upper Devonian.
C. aquisgranense Dantz	Upper Devonian.

and possibly—

C. retiforme Nich. and Murie	Hamilton. (T)

This large group is made up of a number of forms which in themselves admit of no very clear definition, since they are connected by an infinite number of transients, some of which, however, have been distinguished as separate species. Variation in two main features may be taken into account: the degree of crumpling of the laminae and the form of the radial pillars. Considered from this point of view, the group is seen to contain a few conspicuous and abundant forms, e.g., *C. striatellum*, *C. regulare*, *C. clarum* and *C. calamosum*, which are connected by a series of forms in which there is much individual variation. Nicholson in assigning wide limits of variation within those species defined by him showed his full appreciation of these relationships. The species of this group show an advance on those of groups 1 and 2 in the more complete differentiation of the laminae, and it is worthy of note that it contains a large number of Devonian species, while the first two are almost exclusively Silurian.

4. Group of *C. chapmani* Ripper.

This is a rather ill-defined group containing those species of *Clathrodictyon* in which the pillars and laminae are distinct, usually at right angles. The laminae are usually straight.

C. sajanicum Yavorsky	Cambrian.
C. chapmani Ripper	Yeringian. (T)
C. bohemicum Počta	Ee2 (Wenlock).
C. laxum Nich.	Helderbergian.
C. carnicum Charlesworth	Devonian.
C. tschusovensis Yavorsky	Lower part of Upper Devonian.
C. incubonum Yavorsky	Devonian.

and possibly—

C. laminatum Boehnke	Silurian (North Germany).
C. dirschkeimense Boehnke	Silurian (North Germany).

Though none of these groups can be correlated exclusively with a particular stratigraphical horizon, and the progressive changes within the genus *Clathrodictyon* are consequently less obvious than in *Actinostroma*, a general relationship between the prevailing type of skeletal mesh and the horizon can nevertheless be discerned. The first two groups, in which the elements of the skeletal mesh are little differentiated contain mainly Silurian species: the second group, of *C. vesiculosum*, in which the pillars are more distinctly separated from the crumpled laminae, includes two Devonian species, one of which, however, is probably identical with *C. vesiculosum* itself. Further stages in the separation of the pillars and laminae are to be seen in group 3, where the laminae are straight, arched or crumpled only at the points where their downward inflections form the pillars. *C. striatellum* itself is a relatively primitive form in this group, in which the origin of the pillars from the laminae is still clearly recognizable. *C. calamosum* is similar, but has tubular pillars and passes gradually through *C. convictum* into *C. regulare* and *C. clarum*, in which the pillars are solid and the laminae gently arched or straight. This third group has a long range in time, for in addition to containing a large number of Devonian species, many of the forms are characteristic of the Wenlock, though some of these are known to occur at higher levels. *C. striatellum* has also been recorded from the Ordovician.

The type of skeletal structure seen in the species of the fourth group has a long range in time, being observed in the only known Cambrian species, *C. sajanicum* Yavorsky. *C. chapmani* itself appears to have an abnormal skeletal mesh; the laminae are straight, and distinct from the pillars, but the interlaminar spaces are filled with a finer mesh composed of subsidiary incomplete pillars and laminae, a feature suggesting that oversecretion of calcium carbonate has taken place. It is possible that the forms in this group are merely special phases derived from species in group 3 by the action of environmental causes.

The Genera SYRINGOSTROMA and STROMATOPORA.

The genus *Syringostroma* is in some respects intermediate between *Actinostroma* and *Stromatopora*, and some of its species form a complete series, first recognized by Parks (1909), passing by a thickening of the horizontal laminae from forms in which the horizontal and vertical skeletal elements are well differentiated, e.g., *S. nigarense* Parks, to those in which the skeletal mesh is reticulate, e.g., *S. barretti* Girty. The Victorian species of *Syringostroma*, which so far have been found only in the Yeringian fauna of Lilydale, correspond well with the North American species, being described as *S.* aff. *niagarense* Parks, *S.* aff. *ristigouchense* (Spencer) and *S. densum* Nicholson. The first two are early transients in the series, occupying positions between the two species with which affinities are suggested. The third, while approaching *Stromatopora* in the increasing reticulation of the skeletal mesh, is probably only remotely connected with the members of Parks' series, since the skeletal mesh is much finer, and the radial pillars are much more slender than in those species.

As noted in an earlier paper (Ripper, 1937), the species of *Stromatopora* fall into two more or less distinct groups. The group of *S. concentrica* Goldfuss contains many Silurian and Helderbergian species in which the coenosteum is usually latilaminar and in which the horizontal laminae are comparatively well developed. This group includes *S. foveolata* (Girty), *S. typica* von Rosen, *S. constellata* Hall and *S. concentrica* Goldfuss, all of which seem to show a continuation of the tendency towards the thickening of the laminae already seen in *Syringostroma*. This progressive change is well seen in the species of *Syringostroma* occurring at Lilydale (Ripper, 1937) and has been dealt with also by Parks (1909) in describing the Helderbergian species of North America.

The second group, of *Stromatopora hüpschii* (Bargatzky), contains those forms, usually characteristic of the Middle Devonian, in which the horizontal laminae are poorly developed, being reduced to sparsely distributed processes joining the relatively stout, straight radial pillars. Such species are *S. beuthii* Barg., *S. hüpschii* (Barg.), *S. bücheliensis* (Barg.), *S. gentilis* Gortani and *S. lilydalensis* Ripper. It is not at present possible to trace any evolutional connection between these two types of structure in the genus *Stromatopora*.

Evolutional Changes in the Stromatoporoidea.

At least two well defined evolutional changes, affecting four of the genera, are discernible in this group. The evidence for these has been obtained from the examination of British and Victorian material, and from a consideration of the stromatoporoid faunas

occurring elsewhere. In the summary of results which follows frequent reference will be made to the classifications of the species of some of the genera, already given in an earlier section.

(*a*) *Thickening of the Horizontal Laminae.*—This change affects *Actinostroma* (see Fig. 1), *Syringostroma* and *Stromatopora* (see Fig. 2). The genus *Actinostroma* as at present known, includes three main types of skeletal mesh, and its species may consequently be grouped thus:—

1. Group of *A. intertextum* Nich.
2. Group of *A. clathratum* Nich.
3. Group of *A. stellulatum* Nich.

The first group, with dominant, though irregular, radial pillars, giving off at irregular intervals whorls of radiating horizontal processes which coalesce to form the discontinuous horizontal laminae, is almost exclusively Silurian, containing but one Devonian, and one Yeringian species. The second group has a more regular skeletal mesh, in which the laminae are thicker and more conspicuous. The radial pillars are short, undulating, and give off at more regular intervals whorls of lateral processes, which more frequently coalesce to form a horizontal lamina. The species in this group are all of Devonian age, and include one from the Yeringian of Victoria. The third group shows a still more complete development of the horizontal laminae. The radial pillars are long and regular, and the whorls of processes are no longer obvious, but are completely fused in the thickened lamina, which is continuous and solid, usually with small perforations. This group includes both Silurian and Devonian species. The three types of skeletal mesh are readily separated in tangential section. Species belonging to the group of *A. intertextum* usually show at all levels a fairly complete "hexactinellid" mesh, formed by the processes given off from the radial pillars. There is as yet little differentiation of the laminae. In *A. clathratum* and allied species belonging to the second group the tangential section shows an imperfect "hexactinellid" mesh on the levels of the laminae, but between the laminae the pillars tend to be isolated. *A. clathratum* itself is very variable in this respect, and obviously includes a number of transitional forms, in which the lateral processes are to varying extents restricted to definite levels, i.e., those of the laminae. Tangential sections of *A. stellulatum* and allied species (group 3) show a marked increase in the definition of the laminae, which are solid and retain no trace of the "hexactinellid" mesh. The radial pillars are isolated in the interlaminar spaces.

This change expresses itself in the genus *Actinostroma*, therefore, in the increasing concentration of the lateral horizontal processes, given off originally at indefinite intervals, on regularly spaced levels. The horizontal and vertical skeletal elements thus become progressively more distinct. The laminae formed by the

fusion of the lateral processes become thicker and more regular, and, in the most advanced forms, little or no trace of the "hexactinellid" mesh formed by the processes in an imperfect state of fusion remains.

A similar progressive change can be traced in the species of *Syringostroma*. Beginning with the primitive form *S. niagarense* Parks of the Niagaran, in which the exceedingly thin, crowded laminae are crossed by long, thickened pillars, it is possible to arrange these forms in a series in which the laminae, at first concentrated in small groups, become thicker and coalesce. The small groups become separated by interspaces somewhat wider than the normal interlaminar space and occupied usually by astrorhizal canals, and the pillars tend to become restricted to the small groups, so that these are eventually transformed into the latilaminae characteristic of certain species of *Stromatopora*. In tangential sections the radial pillars of the earlier forms are still readily distinguishable and are connected, only on the levels of the laminae, by narrow lateral processes. In later forms the processes are broader and produce a vermiculate mesh in which the pillars are no longer readily distinguishable. The change thus has the effect, in this group of species, of destroying the identity of the laminae and pillars, as separate elements of the skeletal mesh.

This group of species belongs in part to *Syringostroma* and in part to *Stromatopora*, but it is difficult to determine the boundaries of these two genera. Parks (1909) has suggested that *Syringostroma* should include those species in which the thin laminae and round, isolated pillars are still easily recognizable as distinct skeletal elements, while those forms in which the laminae are thick and close together, and in which the radial pillars are no longer distinguishable in tangential section from their connecting processes should be placed in *Stromatopora*. The following is, with additions, the series suggested by Parks:—

Syringostroma niagarense Parks ..	Niagaran.
S. centrotum Girty	Helderbergian.
S. ristigouchense (Spencer)	Helderbergian.
S. consimile Girty	Helderbergian.
S. microporum Girty	L. Helderbergian.
S. barretti Girty	L. Helderbergian.
S. densum Nicholson	U. Helderbergian
Stromatopora constellata Hall	Niagaran.
S. typica von Rosen	Wenlock.
S. foveolata (Girty)	L. Helderbergian.
S. concentrica Goldfuss	Givetian.
S. concentrica var. *colliculata* Nicholson	Givetian (M. Devonian).

The Victorian forms described as *Syr.* aff. *niagarense* Parks and *S.* aff. *ristigouchense* (Spencer) are early transients in this series. The first is somewhat more advanced than *S. niagarense* and the second has not yet reached the stage of thickening of the laminae seen in *S. ristigouchense*.

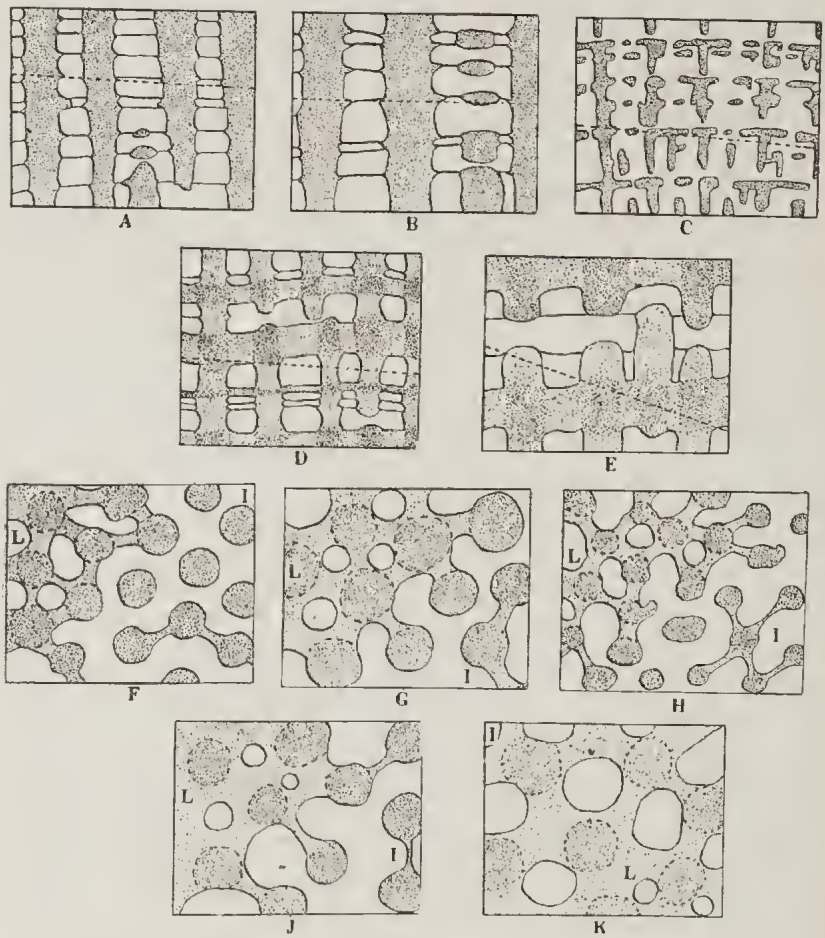

FIG. 2.—Diagrammatic section illustrating the progressive thickening of the laminae in the series *Syringostroma–Stromatopora*. The dotted lines drawn across the vertical section show the approximate positions of the tangential sections. The longer sides of the rectangles represent approximately 1 mm. 2A.—*Syringostroma* aff. *niagarense* Parks. Yeringian. Vertical section. The thick, regular radial pillars traverse a great number of the thin, evenly-spaced laminae. 2B.—*S.* aff. *ristigouchense* (Spencer). Yeringian. Vertical section. The radial pillars have increased in thickness, and the laminae, though still thin, are arranged in small groups. 2C.—*S. densum* Nich. Yeringian and Upper Helderbergian. Vertical section. The mesh is reticulate, made up of the irregular, broken radial pillars and the thickened, discontinuous laminae, which are grouped into latilaminae. This form, while illustrating the progressive change, is probably not closely related to the other members of the series. 2D.—*Stromatopora foveolata* (Girty). Yeringian, Lower Helderbergian and Middle Devonian. Vertical section. The radial pillars are distinct, short, and the laminae are thickened and arranged in small groups, forming latilaminae. 2E.—*S. concentrica* Goldfuss. Givetian. Vertical section. The skeletal mesh

(*continued opposite*)

b. Progressive changes in *Clathrodictyon* (see Figs. 3 and 4).

The species of *Clathrodictyon* fall into four groups:—

1. Group of *C. cystosum* Parks
2. Group of *C. vesiculosum* Nich. & Murie
3. Group of *C. striatellum* (d'Orbigny)
4. Group of *C. chapmani* Ripper,

of which only the first three will be considered here, since the relations of the fourth are as yet imperfectly known. The mesh in the first group, which contains but one Helderbergian species, the rest being Silurian, is completely vesicular, the laminae are crumpled and the spaces of the skeletal mesh are irregular in size and shape, being formed by the downward inflection of the laminae at irregular intervals. In some forms, e.g., *C. cystosum* var. *lineatum* Parks, the laminae become straighter, but distinct radial pillars are still absent. The second group is similar, but the mesh is more regular, and the laminae are straighter, so that the vesicles of the skeletal mesh tend to be arranged in lines. Some forms included in *C. vesiculosum* by Nicholson appear to be transients towards the forms in group 1. This group is mainly Silurian, but includes two species occurring in the Devonian, of which one, *C. confertum* Nich., is probably the Devonian representative of *C. vesiculosum*. In the third group, which contains as well as some forms typical of the Wenlock a large number of Devonian species, the pillars are for the first time recognizable as distinct structures. The skeletal mesh is usually regular, the laminae are slightly crumpled, arched, or straight, and the pillars are complete and at right angles to them. In some of the species e.g., *C. striatellum* and *C. calamosum*, the pillars are still obviously formed by the downward inflection of the laminae, being thickened at their upper ends, conical or tubular. A number of forms occurring in the Victorian faunas may be regarded as being transitional between these species and those, e.g., *C. convictum*

is reticulate, but the radial pillars are still distinct and thick. The laminae are thickened and grouped into latilaminae. 2F.—*Syringostroma* aff. *niagarense* Parks. Tangential section. The radial pillars are usually isolated in the interlaminar spaces (*i*), and are connected by lateral processes on the levels of the laminae (*l*). In this and the following diagrams the positions of the pillars in the horizontal laminae are suggested by the dotted outlines and heavier shading. 2G.—*S.* aff. *ristigouchense* (Spencer). Tangential section. The pillars on the levels of the laminae (*l*) are connected by broader processes, and few are isolated, even in the interlaminar spaces (*i*). 2H.—*S. densum* Nich. Tangential section. Some pillars remain isolated in the interlaminar spaces (*i*). 2J.—*Stromatopora foveolata* (Girty). Tangential section. The radial pillars are sometimes isolated in the interlaminar spaces (*i*), and are connected on the levels of the laminae (*l*) by broad processes, so that the laminae are thick, with small perforations. 2K.—*S. concentrica* Goldfuss. Tangential section. The radial pillars are seldom isolated. The processes connecting them are broader on the levels of the laminae (*l*), so that these have small perforations. The interlaminar spaces (*i*) are thus ill-defined, and the mesh is reticulate.

Yavorsky, *C. regulare* and *C. clarum*, in which the derivation of the solid pillars from the laminae is not so obvious. Some of these forms are closest to *C. regulare* while showing affinities with *C. striatellum*, and others occupy a position between *C. convictum* and *C. calamosum*. These species of *Clathrodictyon* may thus be arranged in the following evolutional series, beginning with the most primitive form:—

C. striatellum (d'Orb.).
C. calamosum Ripper.
C. convictum Yavorsky.
C. regulare (von Rosen).
C. clarum Počta.

This evolutional change expresses itself in the genus *Clathrodictyon*, therefore, in the increasing regularity of the skeletal mesh observed on passing from lower to higher horizons, and in the progressive separation of the horizontal and vertical skeletal elements. The forms in groups 1 and 2, with a more or less completely vesicular mesh are very largely Silurian, though some species belonging to group 3 are also characteristic of Wenlock assemblages. This group, characterized by the regularity of its skeletal mesh, persists into the Devonian, and contains many species which are, as far as known, confined to that system.

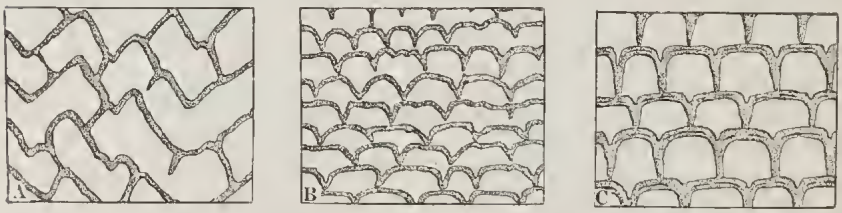

Fig. 3.—Diagrammatic vertical sections illustrating evolution in *Clathrodictyon*. The longer sides of the rectangles represent approximately 1 mm. 3A.—*C. fastigiatum* Nich. Wenlock. Group of *C. cystosum*. The laminae are irregularly crumpled and the radial pillars are imperfect. The skeletal mesh is irregularly vesicular. 3B.—*C. vesiculosum* Nich. & Mur. Wenlock. Group of *C. vesiculosum*. The laminae are minutely crumpled, forming imperfect radial pillars by their downward inflection at fairly regular intervals. The vesicles of the skeletal mesh tend to be arranged in lines. 3C.—*C. regulare* (von Rosen). Wenlock and Devonian. Group of *C. striatellum*. The laminae are arched between the pillars and form regular radial pillars by their downward inflection at regular intervals.

The stratigraphical significance of these progressive changes is shown by the occurrence in the Silurian of assemblages containing species of *Actinostroma* belonging to the group of *A. intertextum* Nich., species of *Clathrodictyon* belonging to the groups of *C. cystosum* Parks, *C. vesiculosum* Nich. and Murie and *C. striatellum* (d'Orb.) (early and intermediate forms), and early transients in the series *Syringostroma–Stromatopora*. *Act. intertextum*, *C. variolare* and *C. striatellum* appear also in the Ordovician, together with many forms of *Labechia*, a genus which,

however, is not dealt with here. Species of *Stromatopora* belonging to the group of *S. concentrica*, e.g., *S. typica* von Rosen, are characteristic of Wenlock assemblages. Middle Devonian assemblages, on the other hand, contain few or none of the more primitive species, and are characterized by the presence of species of *Clathrodictyon* belonging to the group of *C. striatellum*, particularly the most advanced forms, *C. regulare* and *C. clarum*, species of *Actinostroma* belonging to the groups of *A. clathratum* and *A. stellulatum*, and species of *Stromatopora* belonging to the group of *S. hüpschii*. Of the group of *S. concentrica* only the most advanced form, *S. concentrica* itself, is abundant. *Syringostroma* is rare or absent, and of the species of *Clathrodictyon* having a vesicular skeletal mesh only *C. confertum* remains. The primitive group of *A. intertextum* has disappeared. Lower Devonian faunas are transitional, containing intermediate forms in the *Syringostroma–Stromatopora* series, some vesicular species of *Clathrodictyon* and the intermediate forms in the group of *C. striatellum*.

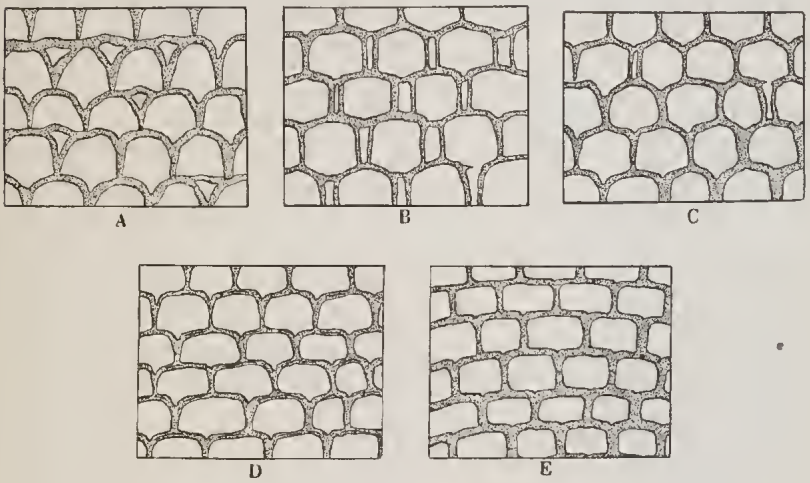

FIG. 4.—Diagrammatic vertical sections illustrating evolution within the group of *Clathrodictyon striatellum* (d'Orb.). The longer sides of the rectangles represent approximately 1 mm. 4A.—*C. striatellum* (d'Orb.). Wenlock. The horizontal laminae are arched, crumpled, and form fairly regular radial pillars which may be conical. 4B.—*C. calamosum* Ripper. Yeringian. The horizontal laminae are becoming straighter, and form by their downward inflection fairly regular pillars which are often tubular. 4C.—*C. convictum* Yavorsky. Upper Oesel Group and Middle Devonian. The horizontal laminae are straight or slightly crumpled; the radial pillars, which are occasionally tubular, are regular. 4D.—*C. regulare* (von Rosen). Wenlock and Devonian. The laminae are arched and form by their downward inflection regular radial pillars which are usually solid. 4E.—*C. clarum* Počta. Devonian. The laminae are straight, rarely crumpled. The radial pillars are straight, solid, complete, and are not obviously formed by the downward inflection of the laminae.

Distribution of Species Occurring in Victoria.

The following list gives the stromatoporoid species so far described from Victoria and the localities at which they occur.

Species.	Localities.						
	Yeringian.		M. Devonian.				
	Loyola.	Lilydale.	Rocky Camp.	Nr. Hicks'.	Citadel Rocks.	Cameron's Quarry.	Heath's Quarry.
Act. verrucosum (Goldf.)	..	x	..	..	..	..	..
A. altum Ripper	..	r.	..	..	..	..	..
A. compactum Ripper	..	c	c	..	..	..	cc
A. stellulatum var *distans* Ripper	..	..	..	..	..	..	cc
A. contortum Ripper	..	..	c	x	..	..	x
Cl. regulare (v. Rosen)	cc	x	..	x	..	..	r
C. regulare var *cylindrifera* Ripper	..	fc	..	..	..	..	..
C. calamosum Ripper	..	fc	..	..	..	..	..
C. chapmani Ripper	aff	r	..	..	..	..	..
C. convictum Yavorsky	..	..	..	..	..	..	x
C. convictum var. *delicatula* Ripper	..	..	r	..	..	c	..
C. clarum Počta	..	..	c	x	..	x	..
Syr. aff. *niagarense* Parks	..	fc	..	..	..	..	..
S. aff. *ristigouchense* (Spencer)	..	c	..	..	..	..	..
S. densum Nich.	..	r	..	..	..	..	..
Str. typica von Rosen	cc	..	..	..	..	..	..
S. foveolata (Girty)	..	fc	..	..	..	..	..
S. aff. *foveolata* (Girty)	..	..	r	..	..	..	..
S. concentrica Goldfuss	..	..	c	c	x	cc	fc
S. concentrica var. *colliculata* Nich.	..	..	x	fc	..	..	fc
S. hüpschii (Barg.)	..	..	?	..	x	..	..
S. aff. *hüpschii* (Barg.)	..	r	..	..	..	..	..
S. bücheliensis (Barg.)	r	c	..	..	..	..	..
S. bücheliensis var. *digitata* Nich.	..	r	..	..	..	..	..
S. lilydalensis Ripper	..	cc	..	..	..	..	..
Hermatostroma episcopale Nich.	..	r	..	..	..	..	r
H. episcopale var. *buchanensis* Ripper	..	..	..	fc	..	..	..
Stromatoporella granulata Nich.	..	r	..	..	..	..	..
S. cf. *damnionensis* Nich.	..	r	..	..	..	..	..
S. sp. indet.	..	r	..	..	..	..	..
Idiostroma oculatum Nich.	..	cc	..	..	..	..	..

In this table :— x indicates the occurrence of a species.
r indicates that it is rare.
fc indicates that it is fairly abundant.
c indicates that it is abundant.
cc indicates that it is very abundant.

Analysis of Victorian Stromatoporoid Faunas.

The fauna of each Victorian locality is analyzed separately. The evolutional stages reached by some of the species, taking into consideration the changes already described, and their stratigraphical significance are then discussed. As seen in a previous

section, the species of four genera may be grouped according to the evolutional stages reached along two lines of development. No evolutional connection beween the species of different genera, with the exception of those of *Syringostroma* and *Stromatopora,* is suggested, however. By placing the Victorian species in their appropriate groups, and determining the proportions of these groups in each fauna by a percentage method, the evolutional stages reached by the assemblages have been evaluated. These data provide the basis for a comparison of the Victorian faunas with one another.

The Yeringian Fauna of the Lilydale Limestone (Ripper, 1933, 1937).—From the point of view of the evolutional stages reached by some of the species, the following analysis of the fauna may be suggested. In this analysis, as well as those which follow, the letter A placed before a group indicates that it has reached an advanced evolutional stage. Those groups marked P are primitive, and the rest occupy intermediate positions in the groups to which they are assigned. The relative proportions of each group in the fauna are indicated by the percentages, which are based on an assemblage of 58 specimens.

1. *Actinostroma.*

	%	
P. Group of *A. intertextum* Nich. ..	1.5	*A. altum* Ripper.
A. Group of *A. clathratum* Nich. ..	10	*A. verrucosum* Goldf. *A. compactum* Ripper.

2. *Clathrodictyon.*

A. Group of *C. striatellum* (d'Orb.) ..	14	*C. calamosum* Ripper. *C. regulare* (v. Rosen) and var. *cylindrifera* Ripper.
Group of *C. chapmani* Ripper	1.5	*C. chapmani* Ripper.

3. *Syringostroma–Stromatopora* transients.

14	*Syr.* aff. *niagarense* Parks. *S.* aff. *ristigouchense* (Spencer). *S. densum* Nich.
5	*Str. foveolata* (Girty).

These are early and moderately advanced transients in this series.

4. *Stromatopora.*

	%	
A. Group of *S. hüpschii* (Barg.) ..	34	*S.* aff. *hüpschii* (Barg). *S. bücheliensis* (Barg.) and var. *digitata* Nich. *S. lilydalensis* Ripper.

The Yeringian Fauna of the Limestone at Griffith's Quarry, Loyola (Ripper, 1937).—This small fauna contains as far as at present known, only four species, of which three have already been described from other regions: The fourth is closely

allied to *Clathrodictyon chapmani* Ripper of the Lilydale limestone. The presence of such typically Silurian species as *C. regulare* and *Stromatopora typica,* and the rarity of the Devonian species *S. bücheliensis* suggests that this fauna may well be somewhat older than that of Lilydale. The percentages in the following table, showing the relative abundance of these species, are based on an assemblage of 17 specimens, excluding a few of doubtful affinities.

Species.	Horizon.	Percentage.	Other Localities.
		%	
Cl. regulare (v. Rosen) ..	Wenlock ..	29	Great Britain, Gotland
C. aff. *chapmani* Ripper ..	Yeringian ..	17·5	Lilydale
Str. typica v. Rosen ..	Wenlock ..	35	Great Britain, Gotland
S. bücheliensis (Barg.) ..	Givetian ..	6·5	Devon. Eifel. Paffrath

The Devonian Faunas of the Buchan District (Ripper, 1937).—In an earlier paper, stromatoporoid faunas were described from five localities in this district. The stromatoporoids are abundant and of varied types, but the faunas are usually made up of a relatively small number of species.

Citadel Rocks, Murrindal River.—Only two species, *Stromatopora concentrica* Goldf. (1 example) and *S. hüpschii* (Barg.) (2 examples), both occurring also in the Middle Devonian limestone of the Torquay district, S. Devon, and in the Givetian of the Eifel, Germany, have so far been found.

Near Hicks', Murrindal.—The evolutional stages reached by those species in which they are determinable, and the relative abundance of those species, are shown in the following analysis of the fauna. The percentages are based on an assemblage of 19 specimens.

1. *Actinostroma.*

A. Group of *A. stellulatum* Nich. ..	*A. contortum* Ripper ..	5

2. *Clathrodictyon.*

A. Group of *C. striatellum* (d'Orb) ..	*C.* cf. *clarum* Počta ..	5
	C. regulare (v. Rosen)	5
Group of *C. chapmani* Ripper	*C.* aff. *chapmani* Ripper	5

3. *Stromatopora.*

A. Group of *S. concentrica* Goldfuss ..	*S. concentrica* Goldf. ..	37·
	and var. *colliculata* Nich.	16

These are the end-terms of the series *Syringostroma Stromatopora.* This assemblage is definitely Middle Devonian in aspect, since the majority of the species occur on this horizon elsewhere,

and of the three most abundant forms, *S. concentrica*, *S. concentrica* var. *colliculata* and *Hermatostroma episcopale* var. *buchanensis* Ripper (26 per cent. of the assemblage), the first two are probably restricted to this horizon. *Cl. regulare*, a species typical of the Wenlock, has been found in the Lower-Middle Devonian of France (Le Maitre, 1934), and this form is also present in the limestones at Heath's Quarry, Buchan.

Cameron's Quarry.—This fauna is a small one, containing only four species, whose relative abundance is shown below. The percentages are based on an assemblage of 15 specimens.

	%
Clathrodictyon clarum Počta	20
C. confertum Nicholson	7
C. convictum var. *delicatula* Ripper	33
Stromatopora concentrica Goldfuss	40

Of these, *C. confertum* and *S. concentrica* are well-known Middle Devonian forms in Europe, and *C. clarum* is abundant in the Lower Devonian (Ff2) of Bohemia. The remaining form is closely allied to *C. convictum* Yavorsky of the Upper Oesel (Upper Silurian) of Kattripank, Oesel, and occurs also, though rarely, in the limestone at Rocky Camp, Buchan.

Rocky Camp, Commonwealth Quarries.—The fauna consists of 9 species, of which 5 also occur in other faunas:—

Clathrodictyon clarum Počta	Ff2—Bohemia.
Stromatopora foveolata (Girty) ..	Helderbergian—New York.
S. concentrica Goldfuss	Givetian—Devon, Eifel.
S. concentrica var. *colliculata* Nich. ..	Givetian—Devon, Eifel.
S. hüpschii (Barg.)	Givetian—Devon, Eifel.

The affinities of the remaining species, and their relative abundance, may best be indicated in an analysis of the fauna, showing the evolutional stages reached by some of the species. The percentages are based on an assemblage of 40 specimens.

1. *Actinostroma.*

		%
A. Group of *A. clathratum* Nich. ..	*A. compactum* Ripper	7.5
A. Group of *A. stellulatum* Nich. ..	*A. contortum* Ripper	42.5

2. *Clathrodictyon.*

A. Group of *C. striatellum* (d'Orb.) ..	*C. regulare* (v. Rosen)	2.5
	C. convictum var. *delicatula* Ripper.	2.5
	C. clarum Počta	12.5

3. *Stromatopora.*

A. Group of *S. concentrica* Goldfuss ..	*S.* aff. *foveolata* (Girty)	2.5
	S. concentrica Goldfuss	20
	and var. *colliculata* Nich.	7.5
A. Group of *S. hüpschii* (Bargatzky) ..	*S. hüpschii* (Barg.)	2.5

The fauna is seen to contain species of *Actinostroma* of Devonian type, in which the laminae have reached a fairly advanced stage of thickening, species of *Clathrodictyon* in which the radial pillars are well separated from the laminae, and the higher transients, belonging to the group of *S. concentrica,* in the series *Syringostroma–Stromatopora.* This assemblage of stromatoporoids is typical of horizons between the Lower and Middle Devonian, the most abundant species being *A. contortum, C. clarum,* and *S. concentrica.*

Heath's Quarry.—The fauna, though rich in individuals, is relatively poor in species, owing to the great abundance of certain forms which dominate the assemblage. Of the 8 species so far described 5 are present in other faunas, and the remaining species are so far known only from Victoria. Their affinities are indicated in the analysis of the fauna, which shows also the relative abundance, expressed in percentages of an assemblage of 60 specimens, of the species.

		%
1. *Actinostroma.*		
A. Group of *A. clathratum* Nich. ..	*A. compactum* Ripper	38
A. Group of *A. stellulatum* Nich. ..	*A. stellulatum* var. *distans* Ripper	30
	A. contortum Ripper	5
2. *Clathrodictyon.*		
A. Group of *C. striatellum* (d'Orb.) ..	*C. regulare* (v. Rosen)	1.5
	C. convictum Yavorsky	5
3. *Stromatopora.*		
A. Group of *S. concentrica* Goldfuss ..	*S. concentrica* Goldf.	10
	and var. *colliculata* Nich.	.9
4. *Hermatostroma.*		
H. episcopale Nicholson		1.5

The most abundant forms, *A. stellulatum* var. *distans, S. concentrica* and its variety *colliculata* are well-known Middle Devonian species while *A. compactum,* also occurring, though less abundantly, in the Yeringan limestone of Lilydale, is of the same type as *A. clathratum* Nich. of Middle Devonian age in Europe. The whole assemblage indicates, therefore, a Middle Devonian age, while containing a small proportion of forms usually occurring at lower horizons, e.g., *C. regulare* and *C. convictum.* Continued work on stromatoporoid faunas seems to show that certain species, while attaining a maximum development at definite horizons, may not be restricted to these horizons, but may appear in decreasing numbers in later assemblages. It is obvious, therefore, that, as in other groups of fossils, the assemblage of stromatoporoids must be considered as a whole, laying particular stress on the evolutional stages reached by certain groups of species, and on the first appearance of new types of skeletal structure.

Comparison of Victorian Stromatoporoid Faunas with one another.

The foregoing analyses of the Victorian stromatoporoid faunas show that they all should probably be placed in the Devonian. The larger of the two Yeringian faunas, that from Lilydale, contains a high proportion of Lower and Middle Devonian species, and the Silurian element, i.e., the early *Syringostroma–Stromatopora* transients, the more primitive members of the group of *Clathrodictyon striatellum* and the members of the group of *Actinostroma intertextum*, is inconspicuous. The other Yeringian assemblage, from Loyola, is poor in species, and may perhaps be on a lower horizon, since of the four forms recognized only one is known to occur in Middle Devonian formations elsewhere, while the two most abundant forms, *C. regulare* (von Rosen) and *Stromatopora typica* von Rosen, are characteristic of the Wenlock of Great Britain and Europe. The marked difference between the assemblages at Lilydale and Loyola may be due largely to differences in facies, since the small size and laminar and encrusting habit of the coenostea at Loyola suggest that they grew under unfavorable conditions. The coenostea at Lilydale, though usually fragmentary, reach a larger size and are frequently massive in habit, but at no time do they approach in size the masses found at some localities in the Buchan district. It is probable, however, that the Yeringian in reality includes a number of calcareous horizons which can be correlated with horizons in Great Britain ranging from the Aymestry Limestone to the Middle Devonian. R. S. Allan (1929) in dealing with the occurrence of the coral genus *Pleurodictyum* in New Zealand, and consequently with its occurrence in the Yeringian of Victoria, also draws attention to this point, and notes that the Yeringian "is not a clearly defined unit, and any exact correlation with the Silurian sequence of Great Britain must be considered entirely provisional."

The five faunas from the Buchan district have definite Middle Devonian affinities, but their relative positions within the Middle Devonian cannot be decided on the evidence of the stromatoporoids alone. As will be seen from the table showing the distribution of the species (p. 236), the faunas are all very similar, though only one species, *Stromatopora concentrica* Goldfuss, is common to all. Other species occurring at two or more of the localities are:—

Actinostroma compactum Ripper.
A. contortum Ripper.
Clathrodictyon regulare (von Rosen).
C. convictum var. *delicatula* Ripper.
C. clarum Počta.
Str. concentrica var. *colliculata* Nich.
S. hüpschii (Barg.).

It may be stated with some reserve that the Rocky Camp fauna may, on account of the presence of *Stromatopora* aff. *foveolata* (Girty) and fairly abundant *C. clarum* Počta, be on a somewhat lower horizon than the rest.

The Buchan faunas are distinct from the Yeringian faunas so far examined on account of the greater abundance of Middle Devonian species. *Actinostroma* is much more abundant than at Lilydale, and is represented, with one exception, by different species. The primitive group of *A. intertextum* Nich, represented by *A. altum* Ripper at Lilydale, and the early *Syringostroma–Stromatopora* transients have disappeared; the latter are replaced by the group of *Str. concentrica,* containing the end-terms of that series. Of this group only a more primitive form, *Str. foveolata* (Girty) is present at Lilydale. Of the species of *Clathrodictyon* only one, *C. regulare,* is common to the two groups of faunas. The others, with the exception of *C. confertum* Nich., occurring at Cameron's Quarry, Buchan, and *C. chapmani* Ripper, occurring at Lilydale, and in a modified form at Loyola, belong to the group of *C. straitellum* (d'Orb.). The abundance of the advanced form, *C. clarum* Počta in the Buchan limestones, is evidence that these are on a higher horizon than that of Lilydale.

The two groups of faunas have the following species in common :—

Act. compactum Ripper.
Cl. regulare (von Rosen).
Str. foveolata (Girty).
Hermatostroma episcopale Nicholson.

H. episcopale, a typical Middle Devonian species, is rare in all faunas, but occurs more frequently, as the variety *buchanensis,* in the Buchan district. *Act. compactum* is much more abundant in the Buchan faunas than at Lilydale. *Cl. regulare,* fairly common at Lilydale and abundant at Loyola, is rare in the Buchan district, as is *Str. foveolata,* of which only one example, differing somewhat from the typical form found at Lilydale, was collected.

The evidence of the stromatoporoid faunas suggests, therefore, that while all the assemblages, with the possible exception of that of the Loyola limestone, have Devonian affinities, the Lilydale fauna should be placed on a lower horizon than those from the Buchan district, which are in the main Middle Devonian.

Summary.

In this paper a comparison of the Victorian stromatoporoid faunas described in earlier papers with one another and with the faunas of other regions is attempted. The data for such a comparison are derived from a consideration of the evolutional changes which can be traced in certain genera. The known species of *Actinostroma, Clathrodictyon, Syringostroma,* and *Stromatopora* are discussed in some detail, and are grouped according to their skeletal structure. The stratigraphical distribution of these groups is outlined, and from this the probable course of evolutional changes within these genera can be deduced. The most important progressive changes, and those likely to be

of stratigraphical importance, are the thickening of the laminae and increasing definition of the pillars in *Actinostroma,* the increasing reticulation of the mesh of species of *Syringostroma* and *Stromatopora,* continuing through the Lower and Middle Devonian, and the straightening of the laminae and the separation of the radial pillars as distinct skeletal elements in the genus *Clathrodictyon.* The Victorian faunas are then analysed, considering the evolutional stages reached by each assemblage. The evidence suggests that the Victorian faunas with the possible exception of the Yeringian fauna of the Loyola limestone, which has Silurian affinities, are of Devonian type, and should probably be placed in the Middle Devonian. The Yeringian fauna of Lilydale contains a higher percentage of types characteristic of the Lower Devonian, and is thus rather older than the Buchan faunas, which are mainly Middle Devonian.

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